

east winds force 8. When the center was over Kiusiu Island, October 1, the afternoon observations from Miyazaki were 728.0 mm. (970.6 mb.) with southeast winds force 9, and from Kagoshima, 727.0 mm. (969.3 mb.) with northwest winds force 6. Newspaper reports in the Manila press of October 2, had an account of the loss of 100 lives in Kiusiu Island due to the typhoon. Many more, fishermen mostly, were missing and a greater total was expected. Property damage amounted to many millions of yen.

The upper winds over Guam were from the east quadrant September 22 and following days, veering to the southeast and increasing to values between 30 and 60 k. p. h. September 25 to 27, as the center passed southwest of the station. Over the Philippines, Aparri, Dagupan, and Manila remained in an easterly (sometimes northeasterly) current until September 30. Cebu and Zamboanga, however, were always reporting winds aloft from the northwest and west quadrants, velocities below 35 k. p. h. until September 28, when an increase to values as high as 70 k. p. h. from the southwest quadrant took place. These high velocities were reported from Cebu more than from Zamboanga, the latter station being consistently in a weaker air stream than Cebu. On these days, September 27 and following, there was a vigorous north quadrant current over China and the northern part of the China Sea. It was also manifested in a few ascents reported from stations of northern Indochina. From the few reports received from Thailand, it seems that these velocities of 50 k. p. h. and higher did not prevail over the southern part of the China Sea and adjacent regions. There was enough evidence during these days to show that two currents of air were interacting over the China Sea, which resulted in the formation of a secondary disturbance described below.

*Typhoon, September 30–October 2, 1941.*—The first information of this typhoon was the report sent by a ship on September 30, 8 a. m. (Manila time) from latitude 12°17' N., longitude 118°58' E., pressure 741.8 mm. (988.9 mb.) and east winds, force 8. At the same time, Culion, Palawan Province, about 80 miles away, had values varying between 752 and 754 mm. (1,000.5 and 1,005.0 mb.) following the normal daily oscillation. This small typhoon moved northerly about 200 miles and inclined to the northeast as it entered central Luzon over the southern part of Zambales Province. It was weakening as this happened (afternoon hours, October 1), and became a rather shallow depression as it moved over the plains of central Luzon. Over the Pacific Ocean, it moved either east-northeast or northeast to the regions about 200 miles east of Balintang Channel, where it disappeared.

The storm was violent over a small area and caused considerable damage to the western shores of Mindoro Island and Batangas Province. At Calatagan, Batangas Pr. (a town about 5 miles north of Cape Santiago, Verde Island Passage), the pressure fell to 738 mm. (983.9 mb.) about 5 a. m. October 1. The winds were always from the west, with no lull, and increasing from 1 a. m. to 5 a. m., then decreasing after 6 a. m.

This typhoon weakened quickly because of two reasons. The first reason was the topography, namely the mountains and hills of Zambales Province. The other reason was the deflection of the northerly current of air, flooding the China Sea, into the southern part of the typhoon circulation. This checked the flow of air from the southern part of the China Sea, which was weak, as explained in the previous typhoon account.

Two lives were lost because of this typhoon. Considerable property damage resulted because of the winds and

the rain (90 percent of the houses at Calatagan were destroyed), and two rather large ocean-going vessels suffered damage when they were blown ashore.

## RIVER STAGES AND FLOODS

By BENNETT SWENSON

Outstanding during September was the continued drought in Eastern States and the continuation of above-normal precipitation west of the Mississippi River. River stages were unusually low in most sections east of the Mississippi River, and in some cases approached or exceeded the lowest stages of record. On the other hand, stages were above normal in most western sections with floods occurring in a belt extending from southeastern New Mexico northeastward to Minnesota and northern Wisconsin. Noteworthy were the damaging floods which occurred in the Pecos River and the Rio Hondo in the vicinity of Carlsbad and Roswell, N. Mex., the rivers and streams in northern Wisconsin, and in portions of the Solomon, Big Blue, Smoky Hill, and Neosho Rivers in Kansas. Floods occurred also in the Canadian River in New Mexico and Oklahoma, the Republican River in Nebraska and Kansas, and rivers and streams in northeastern and southwestern Iowa, and southeastern Nebraska.

*Atlantic Slope drainage.*—River stages were unusually low, approaching, or exceeding, the lowest stages of record in many cases, due to the drought conditions.

The stages in the Susquehanna River approached the lowest of record, but did not equal or exceed the lowest in 30 or 40 years of record. The Delaware River at Trenton, N. J., was below zero from September 13 to the end of the month. In the south, the rivers of the Altamaha system were low throughout the month. At Charlotte, Ga., the Altamaha River reached a low stage of only 0.5 foot above the lowest stage of record, while at Doctortown, Ga., it equaled the lowest of record, —2.3 feet. At Dublin, Ga., the Oconee River reached a stage of 0.7 foot, just 0.1 foot above the lowest of record.

*Ohio Basin.*—The Tennessee River was low and, under control of the Tennessee Valley Authority dam system, the range in stage at Johnsonville, Tenn., was only 1.7 feet (2.3 to 4.0 feet). The precipitation recorded at Asheville, N. C., during September, 0.28 inch, was the lowest of record. In the Ohio River, the dams were up generally throughout the month.

*Upper Mississippi Basin.*—Exceptionally heavy rains on August 29, 30, and 31, in the upper Chippewa and Wisconsin River Basins and also in the Lake Superior drainage in northern Wisconsin, resulted in devastating floods in that area. Maximum stages of record were exceeded in the upper Chippewa and the extreme upper Wisconsin River basins. Total losses from the flooding in the Chippewa Basin alone have been estimated at more than \$1,000,000. The La Crosse, Wis., office makes the following comments on the flood in the Chippewa River:

*Source of Flood.*—On August 29, 30, and 31, excessive and unusually heavy rains fell in the upper Chippewa Basin with maximum intensity and focal point in the northeastern part of Sawyer County. Rains of 60-hour duration in this particular locality amounted to more than half the average season precipitation. An average of over 10 inches fell in Sawyer County and approximately 15 inches in the most intense area. In the lower Chippewa Valley the rains from Durand, Wis., to the mouth of the river were comparatively light. The heavy rain area extended eastward into the upper Wisconsin drainage area and westward into the upper St. Croix Basin. The arithmetical average of 33 stations in the Chippewa drainage of 9,010 square miles was 7.00 inches for a period of 3 days. Approximately 500 square miles received 14 inches; 600 square miles, 12 inches; 600 square miles, 10 inches; 1,500 square

miles, 8 inches; 4,000 square miles, 6 inches; 1,000 square miles, 4 inches; and 800 square miles, 2 inches.

The heaviest downpour of rain occurred in what is known as the "resort" area of Wisconsin where many vacationists were spending the week end and following Labor Day holiday. Many of these were temporarily stranded by washouts on the highways.

*Attendant meteorological factors.*—The synoptic map of August 30th shows a tongue of warm moist tropical air extending up the Mississippi Valley into Wisconsin with a warm front running from Minneapolis eastward into central Michigan. North of Lake Superior there was a mixture of maritime polar, continental, and tropical air masses. It is thought that cold air moving from the northwest over the cold waters of Lake Superior formed a wedge and uplifted the moist air adjacent to the south shore of the lake, thus producing heavy condensation and torrential rains. The effect was no doubt intensified by the retarding action of a large high pressure area over the eastern part of the country resulting in an almost stationary low pressure system in the upper Mississippi Valley. An occasion of this nature may be regarded as extremely rare as maximum 24-hour rainfall amounts appeared to exceed all previous records.

*Hydrologic factors.*—This statement is substantiated by the fact that the U. S. Geological Survey secured the high all time records of flow at Bishop's Bridge and several other streams in the upper reaches of the Chippewa. This was also true for the extreme upper Wisconsin drainage.

A peculiar feature of this flood was that it came at a time when the streams were at extreme base ground flow and rather droughty conditions prevailing. The pasture lands in the lower Chippewa were parched and turning yellow. Cultivated fields were dry and dusty and although the surface was baked and rather hard, conditions were such as to favor a large initial loss with steady and light rainfall. The rains fell at such a maximum rate that they did not have time to percolate into the ground and of such intensity that the damage was considerable in areas far removed from the actual flood plane of the streams. The extreme upper reaches of the Chippewa were focal points of heaviest rainfall, such as the White and Bad Rivers adjacent to the divide, the north slope of which drains into Lake Superior.

The maximum instantaneous peak at Durand, Wis., was 15.45 feet at 4 p. m. of September 2d. The last extreme flood was in September 1928, when the highest stage was 15.2 feet.

*Historic floods.*—The maximum flood previous to this was in June 1905 when the peak stage was 19 feet at Durand. Previous to this there was a flood in the Chippewa of Sept. 11, 1884, with a stage of 27 feet at Eau Claire, Wis. (no record at Durand at this time). This appeared to be the only one exceeding the damage of the present one, which was also greater than the flood of June 1880. Records from the old lumbering days show that an extreme flood occurred in June 1847 when all the sawmills along the river were swept away.

*Damages.*—Damages for this flood were confined to the Chippewa drainage area proper. The St. Croix River received some share of the flood volume but so far as can be determined at this time, the damage in that basin was slight. In the Chippewa Valley an accurate estimate of damages cannot be made until reconstruction is completed. However, it is safe to assume that the total damage will closely approach \$1,500,000. The hardest hit counties were Eau Claire, Chippewa, Price, Lincoln, Washburn, Ashland, and Sawyer. Damage by excessive rains outside of the flood plain would exceed \$750,000 in Sawyer, Oneida, Washburn, and Ashland counties. Federal aid was requested for 1,600 families temporarily driven from their homes by the flood waters. At Chippewa Falls, Wis., the river normally 300 feet wide, formed a lake one-half mile in width. Eau Claire and Chippewa Falls suffered the greatest flood loss. In the Indian village of Odaah (extreme upper Chippewa Basin) about 225 families were forced to vacate their homes. The damage to bridges and highways was considerable all through the Chippewa Valley. Railroad traffic was closed from Eau Claire to Wabasha, Minn., and many of the highways entering Eau Claire and Chippewa Falls were under water.

The highway traffic over the Chippewa at Durand was closed with about one-half mile of highway washed out on the north shore side. Some highway and construction projects at Eau Claire had to be abandoned and some of the structure swept away by the flood. Damage to bridges and highways will exceed \$250,000. In Eau Claire 300 homes were isolated by the flood and about 100 in Chippewa Falls. Red Cross aid was given to the homeless.

The total damages of the Chippewa flood have been estimated as follows:

Tangible property:	
Eau Claire and vicinity	\$75, 000
Hayward and vicinity	100, 000
Chippewa Falls and vicinity	150, 000
Durand and vicinity	15, 000
Outside these cities	500, 000
Construction projects and dams	110, 000
Total	950, 000
Agricultural losses:	
Matured crops	20, 000
Prospective crops	10, 000
Livestock and other movable farm property	10, 000
Total	40, 000
Suspension of business	10, 000
Total known losses	1, 000, 000
Value of warnings	250, 000

*Warnings issued.*—On August 30 the first reports of excessive rains were telephoned to the Weather Bureau. The flood-producing rains were confined to the upper reaches of the Chippewa drainage area, and cautionary warnings were telegraphed to Durand and Eau Claire. A special stage observation was telegraphed from Holcombe, Wis., showing an exceptionally large rise. With further reports of excessive rains received the following morning, the severity of the impending flood was conclusively determined. Warnings of severe flood were then again telegraphed to the radio station at Eau Claire and the observer at Durand with instructions to have the telephone operators call interested parties and especially those living in the bottom lands. Warnings were broadcast every half hour from the radio station on August 31. Residents of Chippewa Falls and Eau Claire had 60 hours advance information of the flood and about 72 hours in Durand and the lower Valley where numerous herds of cattle were pastured. The chief dispatcher of the Northern States Power Co. at Eau Claire deserves appropriate credit both for telegraphing this office the necessary hydrologic information upon which to base the flood warnings as well as for giving out complete information of flood conditions to all parties calling their office.

Additional heavy rains occurred during September in the Minnesota, Wisconsin, and Iowa area, principally during the periods 8th–10th and 15th–16th. The rains during the first of these periods augmented the flow in the Chippewa River so that the crest reached La Crosse, Wis., on the 11th, at a stage of 9.8 feet. The rains of the 15th–16th did not produce a secondary crest at La Crosse, but served to continue the high water throughout the month in the Mississippi River. A large volume of water in the river from above St. Paul, Minn., moving down from the 17th to the 20th and reaching a stage of 9.2 feet at Hastings, Minn., was also a factor in maintaining the high water.

The rainfall on the night of the 15–16th, was exceptionally heavy in the vicinity of La Crosse. On the morning of the 16th, Sparta, Wis., in the La Crosse River drainage, reported 4.03 inches of rain in 24 hours. From the same storm, a flash flood occurred in Coon Creek (8 miles south of La Crosse on the Wisconsin side). Two recording precipitation gages in the upper Coon Creek area, operated by the Soil Conservation Service, reported over 4 inches in 1 hour. This rainfall resulted in a sharp rise in the creek causing considerable damage to railroads and highways. The total damage is estimated at more than \$30,000 and about the same amount of loss was sustained in Monroe County, especially near Sparta, Wis. Some flooding of the lowlands occurred in the Root and Whitewater Rivers, tributaries of the Mississippi in the vicinity of La Crosse on the Minnesota side.

The floods in the Wisconsin River were most severe in the upper portion following the heavy rains of August 29-31. The river reached a crest of 20.5 feet at Knowlton, Wis., at midnight of September 1-2. The previous high floods of which there are records were in July 1912, April 1922, and September 1938, when stages of 19.9, 19.5, and 19.9 feet, respectively, were reached on the Knowlton gage. The crest flattened out downstream and at Wisconsin Rapids and Portage, Wis., the river was only slightly above bankful.

Two other crests occurred at Knowlton, namely on the 6th and 17th from additional rains. These rises, however, were well below the first rise, and resulted in no appreciable further damage.

The total losses from the floods in the Wisconsin River valley have been estimated at about \$300,000.

Heavy to excessive rains occurred over a narrow belt, in east central Iowa, crossing the Wapsipinicon and Maquoketa River valleys on September 7-9. Local amounts for a 72-hour period exceeded 7 inches in several counties and for the counties in the Iowa, Cedar, Wapsipinicon, and Maquoketa River basins the daily averages have been computed as follows: 7th, 0.60 inch; 8th, 2.98 inches; 9th, 0.42 inch.

Moderate floods resulted in the Wapsipinicon and Maquoketa Rivers and local overflows along the lower Cedar and Rock Rivers. The damages in the first two mentioned rivers amounted to an estimated total of \$640,000.

*Missouri River Basin.*—Overflows occurred in the Blue, Solomon, Republican, Saline, and Smoky Hill Rivers during the month with a total estimated damage of approximately \$130,000. The overflow in the Republican River was slight and no appreciable damage occurred in that basin. The Topeka, Kans., office reports as follows on the floods in Kansas:

The overflow in the basin of the Blue River occurred from the 15th to the 19th of the month. Both the Big Blue and the Little Blue overflowed rather badly. At Beatrice, Nebr., a crest stage of 26.3 feet, 10.3 feet above bankful, occurred on the 16th. At Blue Rapids a crest stage of 28.56 feet, 8.56 feet above bankful, occurred on the 18th. At Randolph a crest of 24.1 feet, 4.1 feet above bankful, occurred on the 19th. Along the Little Blue River the crest stages were from 2 to 3 feet above bankful.

The Solomon River reached a crest of 28.9 feet, 10.9 feet above bankful, at Beloit on the 5th. At Niles the crest was 24.6 feet, which was only 0.6 foot above bankful, and occurred on the 16th.

The overflow along the Smoky Hill River proved rather serious. At Lindsborg a crest of 28.3 feet, 7.3 feet above bankful, occurred on the 4th; at Salina a crest of 22.7 feet, 2.7 feet above bankful, occurred on the 6th; and at Enterprise a crest of 26.8 feet, 0.8 foot above bankful, occurred on the 9th.

*Arkansas River Basin.*—Moderate to severe flooding occurred in the Cottonwood and Neosho Rivers in Kansas. The Cottonwood River reached a stage of 25.4 feet at Emporia, 5.4 feet above bankful, on the 7th. In the Neosho River, the flooding was more pronounced in the reach from Iola, Kans., to the Oklahoma line. At Iola, the crest was 20.5 feet, 5.5 feet above bankful, on the 6th. The crest moved downstream, reaching Chanute, Kans., on the 8th with a stage of 26.0 feet, 6 feet above bankful; Parsons, Kans., on the 11th, with a stage of 26.2 feet, 4.2 feet above bankful; and Oswego, Kans., on the 11th with a stage of 23.0 feet, 6 feet above bankful. The overflow at Parsons and Oswego extended over a period of 7 to 8 days. The total damages from the

flooding in the Cottonwood and Neosho Rivers in Kansas is estimated at approximately \$275,000.

Excessive rains in the upper watershed of the Walnut River and in the Whitewater Creek area in Kansas caused an overflow in the two streams from September 1-4. The flood waters moved down the Walnut River to Arkansas City, Kans., but the only damage reported was in Butler County, in the vicinity of Augusta, Kans., and above; the high water, to the extent of damaging proportions, reached Augusta late on the 3d. Warnings were issued on the morning of the 3d. The damage from the high water in Butler County was estimated by the county engineer at \$176,500 and a saving from warnings of \$25,000 was reported.

The Canadian Rivers overflowed from frequent rains during the month in northeastern New Mexico, the Texas Panhandle, and Oklahoma. At Woodward and Canton, Okla., the North Canadian River was above flood stage on the 25th and 26th, while at Yukon, Okla., the river exceeded flood stage from September 2 and was still in flood at the close of the month. The crest at the latter place was reached on the 28th, with a stage of 13 feet. At Canadian, Tex., and Union City, Okla., the Canadian River was from 2 to 3 feet above bankful on September 24-25.

*West Gulf of Mexico drainage.*—Floods occurred in Texas and New Mexico, principally in the Pecos River at and below Roswell, N. Mex., the lower Rio Grande, and in the lower Nueces River at and below Three Rivers, Tex. The latter stream was in flood at Three Rivers from the 18th to the 21st, with a peak stage of 41.4 feet (flood stage, 37 feet) on the 19th.

Precipitation was phenomenally heavy in New Mexico, and disastrous floods occurred in the Rio Hondo and in the Pecos River. The following is quoted from the general summary of the New Mexico Climatological Data for September:

The month was the wettest of the entire half century of State-wide weather records in New Mexico. Precipitation averaged 5.97 inches; over 4 inches above normal, 1.63 inches wetter than any previous September, and 1.14 inches more than July 1914, the previous record wet month. All watersheds received above normal rainfall, with departures ranging from +1.69 in the San Juan and Northern Rio Grande to +6.23 in the Pecos Valley. The phenomenal rainfall was the result of two storm periods, the 20th to the 23d, and the 28th-29th. The former was confined principally to the east and south-central portions of the State, where several serious flash floods occurred; the principal one at Carlsbad, between 8 and 9 o'clock on the evening of the 20th, where 11 persons were drowned and property loss was large. This flood exceeded the one on May 21, but people had not been allowed to resettle in the ordinarily dry Dark Canyon Creek bed, a move which undoubtedly saved many lives. An unofficial but reliable rainfall measurement at the head of Dark Canyon indicated 17 inches of rainfall from Saturday noon, 20th, to 6 p. m. of the 21st, and 10 inches of that amount in the 6 hours ending at 6 p. m. of the 20th. Much of Roswell was inundated on the 22d to the 24th from Rio Hondo floodwater and all western tributaries of the Pecos experienced damaging floods; crops, highways, and bridges being most severely damaged. The second storm period, the 28th-29th, was a general, heavy rainstorm which overspread the entire State with some important damage along the Gila River to highways and bridges, and another more serious inundation at Roswell which continued from the 29th into the first days of October. Total loss of life due to floods was 15, and property losses will run into several hundred thousands of dollars, possibly over a million.

This month climaxed the period of abnormal wetness which commenced in the autumn of 1940, bringing the average precipitation for the past 12 months to 27.55 inches, and for the first 9 months of 1941 to 24.01 inches. This latter figure exceeds by over

